GPS Receivers with NMEA Output

principles and applications

By G. May DL3ABQ

GPS modules with NMEA output are available for less than 80 pounds, and compact hand-held GPS units with the interface are now hardly any more expensive. This article shows what can now be done with these units.

The Global Positioning System (GPS) allows the user to determine very accurately his position in space. Since the artificial error introduced for civilian users has been switched off, the accuracy is now around 20 to 50 m, and in practice an error of rather less than 10 m can be achieved. Using Differential GPS (DGPS) the accuracy can be improved still further with the aid of correction information.

GPS receivers have been getting cheaper and cheaper. Basic units are available for just over one hundred pounds. More user-friendly devices with more sophisticated mapping software, however, still command a rather higher price. If you are not interested in the ultimate in miniaturisation, there is an economical alternative: you can buy a 'pure' receiver without display, but equipped with a data output which you can connect to a port of your PC or hand-held computer. Such modules are available for under a hundred pounds, and suitable GPS mapping software for the PC is also not expensive.

The GPS Receiver

As can be seen from **Figure 1**, the GPS receiver circuit divides into two or three main parts: the antenna, which in some systems is separate from the rest of the device and which normally contains a preamplifier, the receiver proper, and a control circuit. The control circuit usually takes the form of a microprocessor with associated display and keyboard. Optionally a DGPS receiver can be incorporated, which receives a broadcast DGPS correction data signal.

A more detailed block diagram appears in **Figure 2**, taken from the data sheet of the Jupiter LP receiver module from Conexant (formerly Rockwell). The actual GPS receiver is generally built around a chipset consisting of two manufacturer-specific components. The HF frontend (or 'RF monopac') receives and demodulates the GPS signal. The rest of the job —

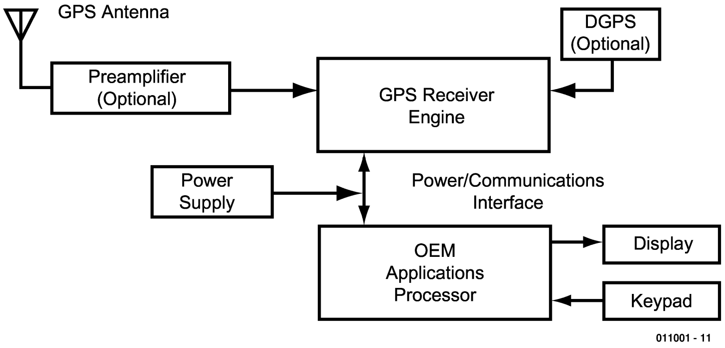

Figure 1. Block diagram of a complete GPS receiver.

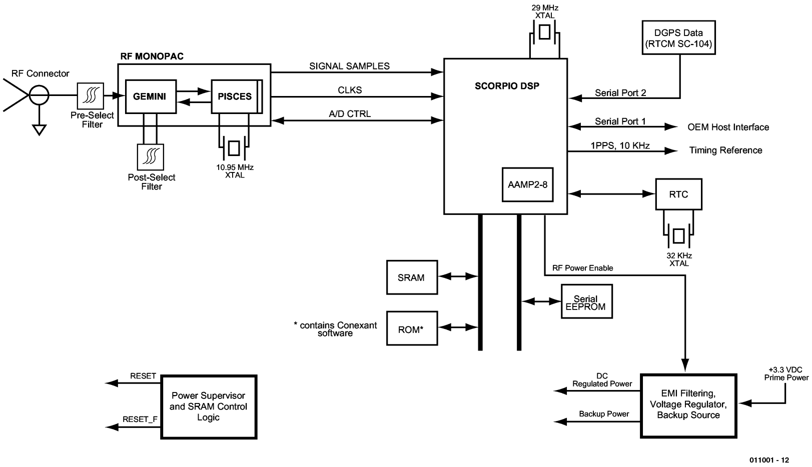

Figure 2. Block diagram of a GPS receiver module.

Figure 3. High-specification GPS receiver.

the processing and decoding of the GPS signals and the control of the frontend — is performed by a dedicated digital signal processor (DSP).

The hardware and the software form a significant part of the cost of a complete GPS receiver. That goes especially for large colour TFT displays, as well as mapping software and databases. **Figure 3** shows an example of a high-specification GPS receiver. We can do the same job by buying a simple receiver and using it in conjunction with a PC. The simple receiver can be a GPS module like the one shown in **Figure 4** or a so-called 'GPS mouse' (**Figure 5**), with integral antenna. Only a little dearer is a basic hand-held GPS receiver, such as the tiny Garmin device shown in **Figure 6**, which offers only a simple user interface–but also a data interface.

To use this interface it is if course essential that the PC software and the receiver communicate using a standardised protocol.

NMEA

NMEA is a communications protocol that was developed for data interchange between electronic sensors in marine applications.

Since GPS quickly found application in this area, NMEA has also established itself as a protocol standard for communications between GPS receivers and terminal equipment. Despite this there are still a few receivers around that use their own protocol. Since practically all PC applications use NMEA, these receivers should be avoided.

By 'NMEA' here we mean 'NMEA 0183', of which versions 1.5 and 2.0 are widely used. Generally version 2.0 is encountered, and newer receivers tend not to support the older versions (NMEA 0183 version 1.5, NMEA 0182 and NMEA 0180).

The NMEA output of the receiver is connected to the serial port of the PC. The RS232 parameters for the protocol are 4800 baud, 8 data bits, one stop bit and no parity. Observe that some receivers use TTL or CMOS levels at their interfaces; such units require the use of a level-shifter circuit. A suitable level shifter is the well-known standard MAX232 circuit shown in **Figure 7**.

If, however, the unit's manual claims that the device can be connected directly to a PC, no such complications are necessary.

NMEA Sentences

NMEA data is divided into records each at most 80 characters long, called sentences. The NMEA sentences can easily be displayed using a terminal program such as Hyperterminal for Windows or the Norton Commander terminal. The data can be read directly, since the sentences consist of printable ASCII characters. There are, however, rather more user-friendly alternatives, which we will describe in more detail below.

The sentences start with a '$', followed by a system ID, which in the case of a GPS receiver is 'GP'. The individual data fields follow.

In **Table 1** an RMC sentence is shown as an example, as generated by all GPS receivers (RMC = Recommended minimum specific GPS/Transit data). A full overview of the sentence format can be found at the NMEA FAQ [1].

PC Software

The best GPS receiver in the world is little use if there is no software to display its data satisfactorily. Fortunately there is a huge choice of free programs available for this purpose, of which a few are described briefly below:

GPSS (see **Figure 8**)
A highly recommended freeware program including map display. Unfortunately the user interface takes a little getting used to. The download address is www.gpss.co.uk/

NMEA Monitor
A freeware program to display NMEA data. Downloadable from
www.navtec.de/english/nmea_mon.htm

WinGPS
A very powerful commercial program with map display; a shareware version is available for download from www.stentec.com/

This is of course only a small selection; in particular there is no shortage of NMEA monitor programs. For portable use there is also software available for Palm and Psion machines etc.

Generally the programs that are capable of displaying maps already have some built in; more can be obtained, for example, from the well-known 'TOP 50' CDs or other collections of map data. In general the maps have to be calibrated using a couple of known fixed points on the map.

APRS

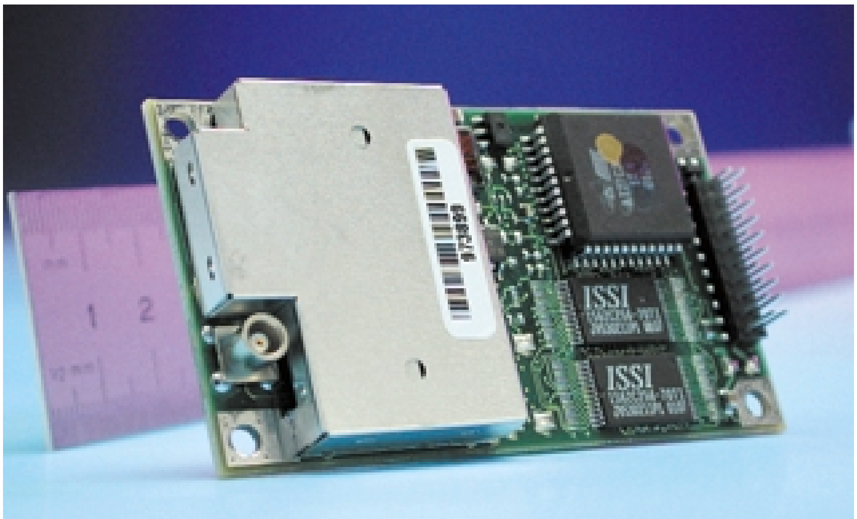

Figure 4. Example GPS module.

Table 1

Example sentence:

RMC,225446,A,4916.45,N,12311.12,W,000.5,054.7,191194,020.3,E*68

225446	time of fix: 22:54:46 UTC (Universal Time Coordinated)
A	GPS receiver status (A: normal; V: warning)
4916.45,N	latitude: 49° 16.45' north
12311.12,W	longitude: 123° 11.12' west
000.5	speed
054.7	course
191194	Fix-Date: 19 November 1994
020.3,E	magnetic variation: 20.3° east
*68	checksum

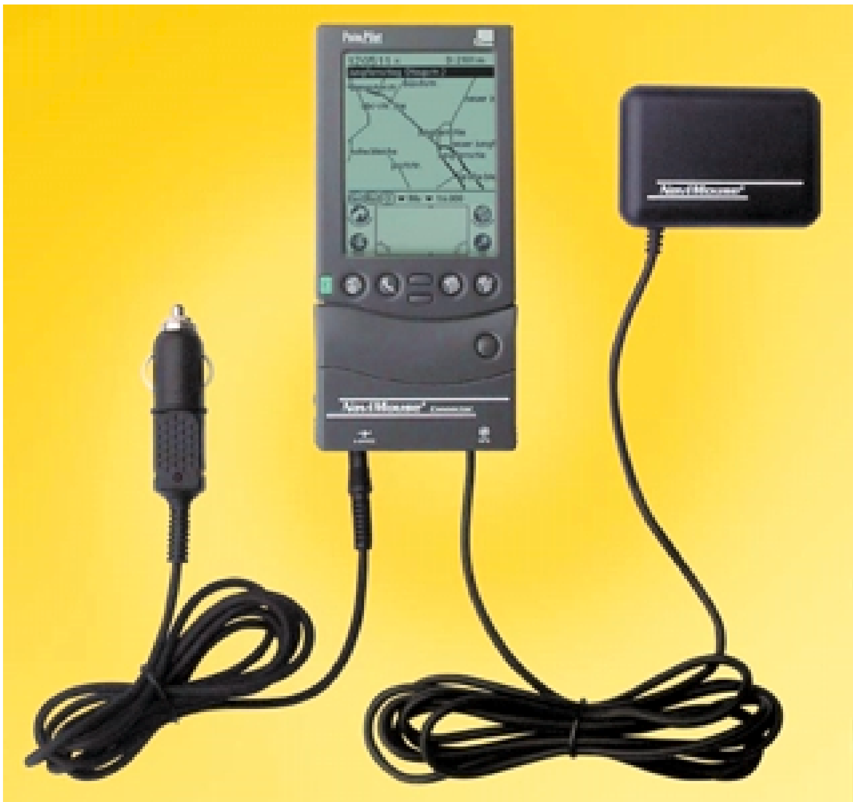

Figure 5. A 'GPS mouse' includes a compact GPS receiver with integral antenna and can, according to the model, be connected directly to a PC's serial port or USB port. The photograph shows a NaviMouse (sold by Unitronic) for connection to a Palm PDA.

'APRS' (Automatic Positioning Reporting System) is a new amateur radio system wherein a GPS receiver with NMEA output is connected to amateur radio equipment. The various stations can then exchange position information. More information is available from:
www.didIdahdahdidit.com/

Internet Links

There is a huge range of resources on GPS and NMEA worldwide. To conclude this introductory article we present a small selection:

GPS Primer
www.aero.org/publications/GPSPRIMER/index.html

National Marine Electronics Organisation www.nmea.org

Trimble
www.tri-m.com/products/trimble_navigation_ltd.products.html

CommLinx, an Australian supplier of GPS modules
http://commlinx.com.au/gps_oem.htm

Joe Mehaffey and Jack Yeazel's GPS Information Website
http://joe.mehaffey.com/

Peter Bennett's GPS and NMEA Site
http://zazu.optiva.ee/pub/nmea/

The Global Positioning System (GPS) Resource Library www.gpsy.com/gpsinfo/

GPS newsgroups
alt.satellite.gps
www.yahoogroups.com
(by subscription only; search for 'GPS')

(011001-1)

Figure 6. Even low-cost hand-held GPS units are available with NMEA output.

References:

- [1] Bennett, Peter (2000): The NMEA FAQ Version 6.3 (http://vancouver-webpages.com/peter/nmeafaq.txt)
- [2] GPS receivers (Figures 3 and 6): www.garmin.de
- [3] GPS receivers (Figures 4 and 5): www.unitronic.de
- [4] Block diagrams (Figures 1 and 2): www.conexant.com

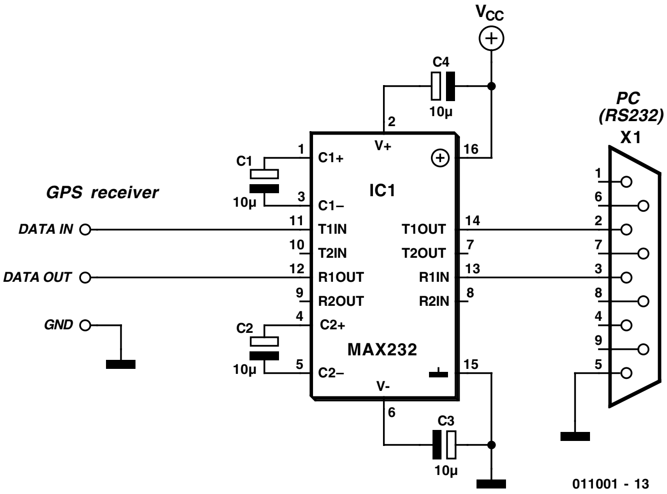

Figure 7. Some receivers require a level shifter to connect to an RS232 port. This standard MAX232 circuit fits the bill.

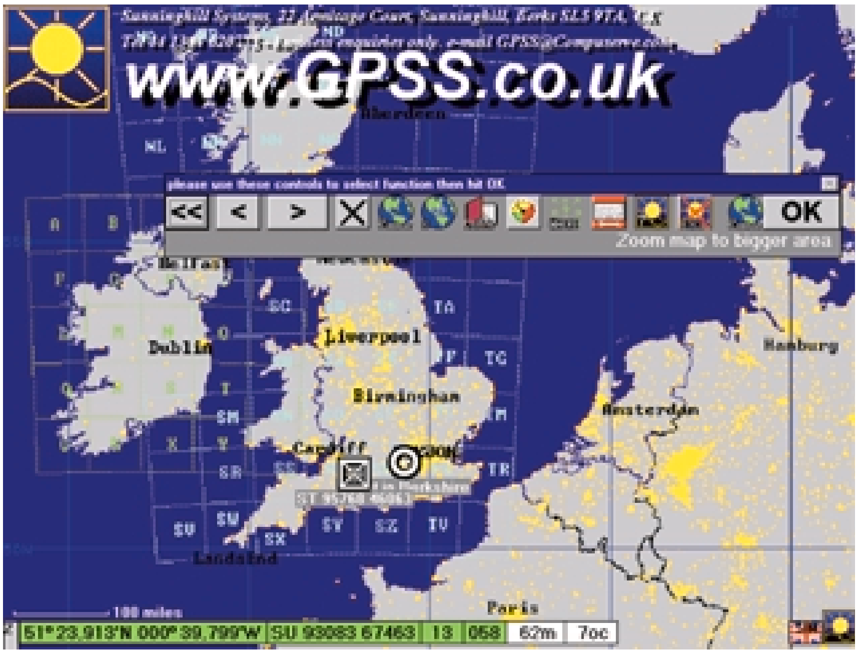

Figure 8. GPSS is a highly recommended freeware program that includes map display.